

IRRIGATION WATER CONVEYANCE (FT)

Pipeline Steel

Definition

A pipeline and appurtenances installed in an irrigation system.

Scope

This standard applies to the design and installation of buried steel irrigation pipelines and steel irrigation pipelines permanently installed above ground. If soil conditions do not permit below ground installation, onground installation is restricted to pipelines not greater than 6 inches in diameter. Pipelines greater than 6 inches installed under these conditions shall be placed on aboveground supports. This standard is restricted to pipelines not greater than 48 inches in diameter and does not apply to short pipes used in structures such as siphons, outlets from canals, and culverts under roadways.

Purpose

The conservation objectives of this pipeline practice are to prevent erosion or loss of water quality or damage to the land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

Conditions Where Practice Applies

This practice applies where the pipeline shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

All lands served by the pipeline shall be suitable for use as irrigated land.

Water supplies and irrigation deliveries to the area shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Design criteria

A. Working Pressure and Flow Velocity

The pipeline shall be designed to meet all service requirements without the use of a working pressure which will provide tensile stresses in the pipe greater than a design stress equal to 50 percent of yield-point stress. Design stresses for commonly used steel and steel pipe classes are shown in column 2 of Table 1.

Table 1

Specification and Grade of Steel	Design Stress 50% Yield Point - p.s.i.
ASTM A 283	
Grade B	13,500
Grade C	15,000
Grade D	16,500
ASTM A 570	
Grade A	12,500
Grade B	15,000
Grade C	16,500
Grade D	20,000
Grade E	21,000
AWWA C 200	
Furnace butt weld	12,500
Grade A	15,000
Grade B	17,500
Grade X42	21,000

In computing tensile stresses in steel pipe, the following items must be considered:

1. The pressure to be delivered at the end of the pipeline.
2. The friction head loss.
3. The elevation differential between the outlet and the inlet of the pipe.
4. Any pressure due to water hammer or surge which may be created by the closure of a valve in the pipeline.

B. Flow Capacity

The design capacity shall be based upon whichever of the following is the greater:

1. Capacity to deliver sufficient water to meet the weighted peak consumptive use rate of the crops to be grown.

2. Capacity sufficient to provide an adequate irrigation stream for the methods of irrigation to be used.

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C. Minimum Wall Thickness

Minimum pipe wall thickness shall be as follows:

4"	through	12"	nominal diameter	-	14 gage less 12.5%
14"	through	18"	nominal diameter	-	12 gage less 12.5%
20"	through	24"	nominal diameter	-	10 gage less 12.5%
26"	through	36"	nominal diameter	-	3/16 inch less 12.5%
38"	through	48"	nominal diameter	-	1/4 inch less 12.5%

D. Friction Loss

For design purposes the pipeline friction loss shall be based on that computed with Manning's formula with "n" equal to no less than 0.012 for unlined pipe and no less than 0.010 for lined pipe.

E. Check, Pressure Relief, Vacuum Release, and Air Release Valves

Where detrimental backflow may occur, a check valve shall be installed between the pump discharge and the pipeline.

A pressure relief valve shall be installed at the pump location when excessive pressure can be developed by operating with all valves closed. Also, in closed systems where the line is protected from reversal of flow by a check valve and excessive surge pressures could be developed, a surge chamber or pressure relief valve shall be installed close to the check valve on the side away from the pump.

Pressure relief valves shall be no smaller than 1/2-inch nominal size for each diameter inch of the pipeline, and shall be set at a maximum of 5 p.s.i. above the safe working pressure of the pipeline.

A pressure relief valve or surge chamber shall be installed at the end of the pipeline when needed to relieve surge.

Air release and vacuum release valves or combination air release - vacuum release valves shall be placed at all summits in the pipeline, at the end of the line, and between the pump and check valve when needed to provide a positive means of air entrance or escape.

Air release and vacuum release valve outlets shall be at least 1/2-inch nominal diameter when specified for lines of 4-inch diameter or less, at least 1 inch outlets for lines of 5- to 8-inch diameter, at least 2-inch outlets for lines of 10- to 16-inch diameter, at least 4-inch outlets for lines of 18- to 28-inch diameter, at least 6-inch outlets for lines of 30- to 36-inch diameter, and at least 8-inch outlets for lines of 38- to 48-inch diameter.

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For pipelines larger than 16-inch diameter, 2-inch air release valves may be used in place of the sizes indicated above if they are supplemented with vacuum release valves that will provide vacuum release capacity equal to the sizes shown.

F. Draining and Flushing Requirements

Provisions shall be made for draining the pipeline completely where a hazard is imposed by freezing temperatures or drainage is specified for the job.

Where provisions for drainage are required, drainage outlets shall be located at all low places in the line. These outlets may drain into dry wells or to points of lower elevation. If drainage cannot be provided by gravity, provisions shall be made to empty the line by pumping.

G. Outlets

Appurtenances to deliver water from a pipe system to the land, to a ditch, or to a surface pipe system shall be known as outlets. Outlets shall have capacity to deliver the required flow:

1. To a point at least six inches above the field surface.
2. To the hydraulic gradeline of a pipe or ditch.
3. To an individual sprinkler, lateral line, or other sprinkler line at the design operating pressure of the sprinkler or line, as the case may be.

H. Pipe Supports

Irrigation pipelines placed above ground shall be supported by suitably built concrete or timber saddles shaped to support the pipe throughout the arc of the contact, which shall be not less than 90°

nor more than 1200 as measured at the central angle of the pipe. Where needed to prevent overstressing, ring girder type supports shall be used. Support spacing shall be such that neither the maximum beam stresses in the pipe span nor the maximum stress at the saddle will result in stresses exceeding the design stress values.

I. Anchors, Thrustblocks, and Expansion Joints

For above-ground pipelines with welded joints, anchor blocks and expansion joints shall be installed at spacings that will limit pipe movement due to expansion or contraction to a maximum of 40 percent of the sleeve length of the expansion coupling to be used. The maximum length of

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pipeline without expansion joint shall be 500 feet. Aboveground pipelines with rubber gasket type joints shall have the movement of each pipe length restrained by steel holddown straps at the pipe supports or by anchor blocks in lieu of normal pipe supports.

Anchor blocks usually will not be required on buried pipelines. Expansion joints shall be installed as needed to limit stresses in the pipeline to the design values.

Thrust blocks are required on both buried and above ground pipelines at all points of abrupt changes in grade, horizontal alignment, or reduction in size. The blocks must be of sufficient size to withstand the forces tending to move the pipe, including those of momentum and pressure as well as forces due to expansion and contraction.

J. Joints and Connections

All connections shall be designed and constructed to withstand the working pressure of the line without leakage and leave the inside of the pipeline free of any obstruction that would reduce the line capacity below design requirements. On sloping lines, expansion joints shall be placed adjacent to and downhill from anchors or thrust blocks. Where cathodic protection is required, high resistance joints shall be bridged to insure continuous flow of current.

A dielectric connection shall be placed between the pump and the pipeline and between pipes with different coatings.

K. Corrosion Protection - Pipe interior

Interior protective coatings shall be provided where the pH of the water conveyed is 6.5 or lower. Cement mortar coatings may be used

when the water to be conveyed has a pH of 5.5 or higher and a sulfate content of 150 ppm or less.

L. Pipe Exterior - Underground Lines

All pipe exteriors must be provided with full protection against corrosion. To meet protection requirements, all pipe must be coated and must be provided with supplementary cathodic protection as specified in item 2 below.

1. Criteria for Determining Class of Coating

Class A protection coating shall be provided when the soil resistivity survey shows either (1) twenty percent or more of the total surface area of the pipeline will be in soil which has a resistivity of 1500 ohm-cm or less; or (2) ten percent or more of the total surface area of the pipeline will be in soil which has a resistivity of 750 ohm-cm or less. Class B coating shall be

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provided for all other soil conditions.

2. Cathodic Protection Requirements

Supplementary cathodic protection shall be provided when the soil resistivity survey shows any portion of the pipeline will be in soil whose resistivity is less than 10000 ohm-cm unless galvanized pipe is used. Pipe to soil potential shall be not less than 0.85 volts negative, referred to a copper/copper-sulfate reference electrode, with the cathodic protection installed. The initial anode installation shall be sufficient to provide protection for a minimum of 15 years.

Cathodic protection shall be provided for galvanized pipe when the soil resistivity survey shows any portion of the galvanized pipe will be in soil whose soil resistivity is less than 4000 ohm-cm. Galvanized pipe requiring cathodic protection shall have class B coating.

The total current required, the kind and number of anodes needed, and the expected life of the protection may be estimated as shown:

- a. The total cathode current required may be estimated from the formula:

$$I_t = [C A_1/R_{e1} + A_2/R_{e2} + \dots A_n/R_{en}]$$

Where: I_t = total current requirement in ma

A = surface area of pipe in square feet

R_e = soil resistivity in ohm-cm

C = a constant for a given pipe coating

For design purposes this constant shall be considered to be not less than 32 for Class A coatings and not less than 60 for Class B coatings.

- b. The kind of galvanic anode to be used is dependent upon the resistivity of the soils in the anode bed location. If the resistivity of the anode bed is:

(1) less than 2000 ohm-cm use zinc anodes;

(2) between 2000 and 3000 ohm-cm use either zinc or magnesium anodes;

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(3) between 3000 and 10000 ohm-cm use magnesium anodes.

Anodes shall not be required on pipelines where soil resistivity is greater than 10000 ohm-cm.

- c. The number of anodes needed to protect the pipeline may be estimated by dividing the total cathode current requirement of the pipeline by the current output per anode.

Thus: $N I_t / I_m$ and $I_m = k/R$

Where: N = number of anodes needed

I_t = total current requirement in ma

I_m = maximum anode current output in ma

k = constant for a given anode

R = soil resistivity of the anode bed in ohm-cm

- d. The expected life of an anode, based on the use of 17 lb. per ampere year for magnesium and 26 lb. per ampere year for zinc and a utilization factor of 0.80, shall be computed as follows:

Magnesium	Y	=	$47W/I_o$
Zinc	Y	=	$31W/I_o$

Where: Y = expected life in years

W = weight of anode in pounds

I_o = design anode current in ma = I_m unless resistors are used in the anode to reduce current output

Note: If resistors are used to reduce anode current output in order to increase service life, the number of anodes required shall be based on the regulated output of the anode rather than the maximum output, I_m .

3. Soil Resistivity Determinations

Preliminary soil resistivity measurements to determine coating requirements and the approximate amount of cathodic protection needed may be made before the trench is excavated. For this purpose, field resistivity measurements shall be made, or samples for laboratory analysis shall be taken, at least every 400 feet along the proposed pipeline and at points where there is a visible change in soil characteristics.

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Wherever a reading differs markedly from a preceding one, additional measurements shall be taken to locate the point of change. Resistivity determinations shall be made at two or more depths in the soil profile at each sampling station, the lowest depth to be the strata in which the pipe will be laid. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station.

After the pipe trench is excavated, a detailed soil resistivity survey shall be made as a basis for final design of the coating and the required cathodic protection. At this time resistivity measurements shall be made in each exposed soil horizon at intervals not exceeding 200 feet. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station. Where design values for adjacent stations differ significantly, additional intermediate measurements shall be made.

M. Pipe Exterior - Above Ground Lines

All pipe installed above ground shall be galvanized or shall be protected with a suitable protective paint coating, including a primer coat and two or more final coatings.

N. Materials

All materials shall meet or exceed the minimum requirements of this Standard including Engineering Specifications for Materials.

Plans and Specifications

Plans and specifications for Steel Irrigation Pipelines shall be in keeping with this Standard and shall describe the requirements for application of the practice to achieve its intended purposes.